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# Saturn I

**LAUNCH VEHICLE SA-8  
AND LAUNCH COMPLEX 37B  
FUNCTIONAL SYSTEMS DESCRIPTION**

**N65 23185**

**Volume II**

LOX SYSTEM FUNCTIONAL DESCRIPTION,  
INDEX OF FINDING NUMBERS, AND  
MECHANICAL SCHEMATICS

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LAUNCH VEHICLE SA-8  
AND  
LAUNCH COMPLEX 37B  
FUNCTIONAL SYSTEMS DESCRIPTION

VOLUME II  
LOX SYSTEM FUNCTIONAL DESCRIPTION,  
INDEX OF FINDING NUMBERS,  
AND MECHANICAL SCHEMATICS

APRIL 1964

CHRYSLER CORPORATION SPACE DIVISION - NEW ORLEANS, LOUISIANA

## FOREWORD

This volume is part of a ten-volume set that describes the mechanical and electro-mechanical systems of launch vehicle SA-8 and launch complex 37B that function either during the prelaunch countdown or in the event of a launch abort. The mechanical and electromechanical systems of the launch vehicle that function during flight are also described.

The ten-volume set is prepared for the Functional Integration Section, Systems Integration & Operations Branch, Vehicle Systems Division, P&VE Laboratory, MSFC, by Systems Engineering Branch, Chrysler Corporation Space Division under Contract NAS 8-4016.

This volume describes subsystems and components of launch vehicle SA-8 and launch complex 37B that make up the LOX system. The information is presented in three sections: functional description, index of finding numbers, and mechanical schematics. The technical content reflects the functional system design information available on March 3, 1964.

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## SECTION 1

### FUNCTIONAL DESCRIPTION

#### 1.1 INTRODUCTION

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The LOX system supplies LOX to the S-I stage and S-IV stage propulsion systems. A physical and functional block diagram of the system is provided in figure 1-1. As shown in this diagram, portions of the system are located in the S-I stage, the S-IV stage, and on launch complex 37. The launch complex portion of the system consists of: a LOX storage facility, a LOX transfer subsystem, and equipment for controlling and monitoring the operation of LOX system components.

Schematic diagrams are provided in section III to show the arrangement of components within the system and to supplement the description of the system given in subsequent paragraphs. The index of finding numbers provided in section II further supplements the functional description by giving physical descriptions of components shown on system schematic diagrams.

*Author*

#### 1.2 SYSTEM FUNCTIONS

The three major functions of the LOX system are: the storage of sufficient LOX for filling the S-I stage and S-IV stage LOX tanks, the transfer of LOX between the LOX storage facility and the S-I and S-IV stages, and the utilization of LOX in S-I and S-IV stage propulsion systems. System operations involved in the performance of these functions are briefly described in the following paragraphs.

1.2.1 LOX Storage - LOX storage involves the filling and pressurization of the main LOX storage tank and the LOX replenish storage tank. LOX is transferred from mobile tankers to the storage tanks where it is stored for subsequent transfer to the S-I and S-IV stages. After being filled, the storage tanks are pressurized with GOX generated in individual LOX vaporizers. LOX supplies for the two vaporizers are drawn from the storage tanks.

1.2.2 LOX Transfer - LOX transfer between the LOX storage tanks and the S-I and S-IV stages is accomplished through separate transfer lines and is performed in an integrated sequence. Transfer operations are initiated and controlled from control panels in the launch control center (LCC). Each transfer operation can be performed automatically or can be simulated to verify the operation of transfer line components.

1.2.2.1 S-I Stage LOX Transfer Operations. S-I stage LOX transfer includes the following operations: transfer line precool, main fill, replenish line precool, replenish and drain. Brief descriptions of these operations are given below:

- a. Transfer Line Precool. In the transfer line precool operation, LOX flows from the main LOX storage tank through the S-I stage main fill and drain line and into the S-I stage LOX tanks. This initial LOX flow precools the

transfer lines and transfer line components to prevent in-line vaporization of LOX during the main fill operation. Excessive LOX vaporization can overpressurize and block the transfer lines.

- b. Main Fill. During the main fill operation, LOX is pumped from the main storage tank to the five S-I stage LOX tanks at 2500 gpm. The main fill operation is continued until the S-I LOX tanks are filled to within 95 percent of a predetermined LOX mass.
- c. Replenish Line Precool. Replenish line precooling is performed to prevent excessive LOX vaporization in the replenish line during the replenish operation. The line is precooled with LOX that flows from the replenish storage tank, through the replenish line, and into the S-I stage LOX tanks. The replenish line precool operation is performed during the main fill operation so the replenish operation can be started immediately following the main fill operation.
- d. Replenish. Immediately following the main fill operation, the replenish operation is initiated to fill the S-I stage LOX tanks to 100 percent of a predetermined LOX mass. During this operation, LOX is admitted to the tanks from the LOX replenish storage tank by way of the LOX replenish line and a computer-controlled regulator valve. The valve regulates the flow of LOX to compensate for LOX lost due to vaporization and thereby maintains the full LOX level in the tanks.
- e. Drain. During the drain operation LOX is drained from the S-I stage LOX tanks and transferred back to the LOX storage tank. This operation is not a part of a normal countdown sequence and is used only in the event of a launch cancellation.

1.2.2.2 S-IV Stage LOX Transfer Operations. The operations involved in transferring LOX to and from the S-IV stage LOX container are: fill line precool, main fill, replenish line precool, replenish, and drain. During a normal countdown sequence the first four of these operations are performed in sequence to fill the S-IV LOX container. The fifth operation, drain, is performed in the event of a launch abort to remove LOX from the container. Brief descriptions of the operations are given below.

- a. Fill Line Precool. The fill line precool operation is performed to cool the fill line before the main fill operation is initiated. Precooling prevents excessive LOX vaporization that can overpressurize and block the line. During the precooling operation LOX flows from the main LOX storage tank and into the fill line, thereby cooling the line and line components.
- b. Main Fill. During the main fill operation, the S-IV LOX container is rapidly filled to within 98 percent of a predetermined LOX load. LOX is pumped from the main LOX storage tank through the S-IV main fill line and into the S-IV stage LOX container at 1000 gpm.

- c. **Replenish Line Precool.** In the replenish line precool operation the S-IV replenish line is cooled with LOX from the replenish LOX storage tank to reduce in-line vaporization of LOX during replenish operations.
- d. **Replenish.** During the replenish operation, LOX is transferred from the LOX replenish storage tank to the S-IV LOX container until the container is between 99.25 percent and 99.75 percent full with respect to a predetermined LOX load. During this operation a computer controlled regulator valve admits LOX to the S-IV LOX container to compensate for LOX boiloff losses. Just prior to S-I stage ignition the S-IV stage LOX container is topped to the 100 percent full level.
- e. **Drain.** In the drain operation LOX is drained from the S-IV LOX container and transferred back to the main LOX storage tank. This operation is not performed as part of a normal countdown sequence; it is performed only in the event of a launch abort.

1.2.3 **LOX Utilization** - LOX is the fuel oxidizer in the S-I stage and S-IV stage propulsion systems. In both stages, LOX consumption begins just prior to engine ignition and terminates at engine cutoff. In the S-I stage, LOX utilization includes a LOX bubbling operation, LOX tank pressurization operations, and H-1 engine LOX supply and shutoff operations. In the S-IV stage, LOX utilization includes a LOX bubbling operation, LOX container pressurization and RL10A-3 engine LOX supply and shutoff operations.

### 1.3 SYSTEM DESCRIPTION

1.3.1 **Storage Area** - The LOX system storage equipment consists of a 125,000 gallon main LOX storage tank, a 28,000 gallon LOX replenish storage tank, LOX/GOX vaporizers, and a network of lines and valves necessary for filling, draining, and pressurizing the two storage tanks. The main LOX storage tank stores the major portion of the LOX used for filling the S-I and S-IV stage LOX tanks.

The replenish tank stores LOX under pressure and supplies it to the S-I and S-IV stages for topping the LOX tanks and for replenishing LOX losses due to boiloff.

The LOX/GOX vaporizers convert LOX to GOX for pressurizing the main and replenish storage tanks during LOX transfer operations. LOX is supplied to the vaporizers from the storage tanks and is converted to GOX in vaporizer coils. Each vaporizer has a 42-inch diameter fan powered by a 15 hp electric motor. The fan blows ambient air across the LOX vaporizer coils to effect the LOX to GOX conversion.

1.3.2 **S-I stage LOX Transfer Equipment** - LOX transfer to the S-I stage LOX tanks is accomplished through two transfer lines, a main fill line, and a replenish fill line. (See figure 1-1.) Major transfer components within these two lines are described in the following paragraphs.



1.3.2.1 LOX Transfer Pump. The line pressure and flowrate necessary for transferring LOX through the S-I main fill line is provided by LOX Transfer Pump A105. (See figure 3-1.) The pump is driven by a 350 hp motor and provides a 2500 gpm discharge into the transfer line. Operation of the pump is initiated and controlled from the LCC.

1.3.2.2 Main LOX Transfer Control. Main LOX transfer control equipment controls the transfer of LOX to and from the S-I stage through the main LOX transfer line. This portion of the transfer line consists of Pneumatic Valve A31 and Solenoid Valves A2764 and A2765. (See figure 3-2.) The pneumatic valve is opened to allow LOX flow to the S-I stage during the transfer line precool and main fill operations. It is also opened during the drain operation to allow LOX to flow into the main transfer line from the S-I LOX tanks.

1.3.2.3 Fast Replenish Components. The fast replenish portion of the S-I replenish line admits LOX to the S-I LOX tanks during fast replenish operations. Fast replenish components include Pneumatic Valve A52 and Solenoid Valves A2760 and A2761. (See figure 3-2.) The solenoid valves control the Pneumatic Valve A52 and are individually controlled from control panels in the LCC.

1.3.2.4 Slow Replenish Components. The slow replenish portion of the replenish line regulates the admission of LOX to the S-I LOX tanks to compensate for LOX losses due to boiloff. Components that make up this portion of the replenish line are the Throttle Valve A55 and the Pneumatic Relay A58. (See figure 3-2.) The pneumatically operated throttle valve is a multipositioned regulator valve that allows different amounts of LOX flow when positioned to each of several positions. Throttle valve position is determined by the differential pressure applied to the dome of the valve, and this differential pressure is, in turn, regulated by the LOX tanking computer through Pneumatic Relay A58. During the slow replenish operation the LOX tanking computer determines the amount of LOX to be added and transmits signals to the pneumatic relay to position the throttle valve accordingly.

1.3.3 S-IV Stage LOX Transfer Equipment - LOX from the main LOX storage tank and the replenish LOX storage tank is routed to the S-IV stage by way of a common transfer line that interconnects with the S-IV stage at umbilical swing arm No. 2. Major components within this line are described in the following paragraphs.

1.3.3.1 S-IV LOX Transfer Pump. During the main fill operation, LOX is drawn from the main storage tank and pumped through the S-IV LOX transfer line by Transfer Pump A106. (See figure 3-1.) The pump is driven by a 200 hp electric motor and is capable of discharging LOX at 1000 gpm. Operation of the pump is remotely controlled from the LCC.

1.3.3.2 S-IV LOX Transfer Valve Complex. The S-IV LOX transfer valve complex is located in the umbilical tower adjacent to swing arm No. 1 and contains pneumatic and electropneumatic valves that control and regulate LOX flow into the S-IV stage. The transfer valve complex consists of: main fill Pneumatic Valve A4005, replenish Pneumatic Valve A4021, and umbilical line vent Pneumatic Valve A4023. (See figure 3-2.) The main fill valve is opened during the main fill operation to allow LOX discharge

from Transfer Pump A106 to flow into the S-IV fill, replenish, and drain line. The replenish valve is opened during the replenish operation to allow LOX flow from the replenish storage tank to the S-IV stage LOX container.

**1.3.4 LOX Control Equipment and Subsystems** - As shown in figure 1-1, LOX control equipment is located in three areas on launch complex 37. The LOX control panel, LOX components panel, and LOX tanking computer panel are located in propellant loading racks 4 and 5 of the LCC; the LOX pneumatic console is located in the LOX transfer area, and the LOX tanking computer is located in the AGCS.

**1.3.4.1 LOX Control Panel.** The LOX control panel originates commands for LOX system operations and provides indicators for monitoring these operations.

**1.3.4.2 LOX Components Panel.** The LOX components panel provides switches for manual operation of LOX transfer components when the manual mode of operation is selected. This mode selection is made when the FUNCTION SELECTOR switch on the LOX control panel is turned to the MANUAL position. The components panel also provides indicators for monitoring system component operations.

**1.3.4.3 LOX Pneumatic Console.** The LOX pneumatic console provides pneumatic control pressure for the operation of S-I stage LOX transfer line components. The console receives a 3000 psig GN<sub>2</sub> supply from the nitrogen and helium storage battery (Volume IV) and reduces this supply to 750-psig, 120-psig, 50-psig, and 25-psig outputs.

The 750-psig and 25-psig outputs are control mediums used to operate pneumatic devices in the LOX transfer subsystem. The 50-psig output is used for purging the LOX transfer lines, and the 120-psig output is used only as an intermediate stage in developing the 25-psig output. Distribution of GN<sub>2</sub> to S-I LOX transfer components is effected through solenoid valves which are electrically interlocked with the LOX control panel and the LOX components panel through relay logic networks.

**1.3.4.4 LOX Tanking Computer Subsystem.** The LOX tanking computer subsystem regulates the level of LOX loaded into the S-I stage LOX tanks with respect to the LOX mass requirements of a given mission. The system consists of LOX Tanking Computer A83, a LOX tanking computer panel, and a digital indicator panel. The computer is located on the second floor of the AGCS building; the tanking computer panel and the digital indicator panel are located in the LCC.

During S-I LOX loading operations, the LOX tanking computer monitors the pressure head in LOX tank 0-C and interprets the pressure in terms of LOX mass. The computer is programmed to halt the loading operation when the pressure head reaches a predetermined value. This predetermined head pressure corresponds to the LOX mass requirements for given vehicle mission and is displayed at the LOX differential pressure digital indicator panel. Should LOX mass requirements change, the predetermined LOX pressure head can be corrected plus or minus 0.460 psi by means of a telephone-type dial and a toggle switch on the LOX computer panel. The correction factor is "dialed in" with the telephone-type dial and the polarity of the correction

factor is entered by positioning the toggle switch to either the positive or the negative position.

The pressure correction factor is also displayed in the pressure correction digital indicator.

The LOX tanking computer also controls the replenishment of LOX lost in boiloff. During replenish, the computer monitors LOX depletion and controls a throttle valve that admits small quantities of LOX to the S-I LOX tanks to compensate for the LOX depletion.

**1.3.4.5 S-IV Stage Propellant Loading Control System.** The S-IV stage propellant loading control system consists of the S-IV stage propellant utilization (PU) system and control equipment in the ground complex. The PU system consists of a capacitance-type level probe, liquid level sensors, pressure transducers, pressure switches and associated plumbing and wiring. The ground complex control equipment consists of equipment for determining propellant levels and control panels for monitoring and controlling propellant loading. During S-IV LOX loading operations, the system monitors LOX container levels and terminates the operations when LOX reaches a predetermined level. The system also monitors LOX depletion due to boiloff and controls the replenishment of LOX through a modulating replenish valve.

**1.3.5 S-I Stage Components and Subsystems -** Major components and subsystems in the S-I stage portion of the LOX system are identified in figure 1-1 and described in the following paragraphs.

**1.3.5.1 S-I Stage LOX Tanks.** The S-I stage contains one center LOX tank O-C surrounded by four outer LOX tanks O-1, O-2, O-3 and O-4. (See figure 3-3.) The four outer tanks are mounted alternately between four fuel tanks. Suction lines from each outer tank supply LOX to one inboard and one outboard engine. Each outer LOX tank measures 70 inches in diameter and 677 inches in length and has a maximum capacity of 10,912 gallons. Ullage, provided for expansion and pressurization of the LOX, reduces the liquid capacity of the tanks to 10,425 gallons. The center tank measures 105 inches in diameter and 677 inches in length. The central tank liquid capacity is 24,271 gallons, with ullage reducing the usable capacity to 22,980 gallons.

**1.3.5.2 S-I Stage LOX Tank Pressurization Subsystem.** The S-I stage LOX tank pressurization subsystem regulates LOX tank pressure to maintain an approximately constant LOX pressure head during vehicle flight.

**1.3.6 S-IV Stage Components and Subsystems -** Major components and subsystems that comprise the S-IV stage portion of the LOX system are identified in figure 1-1 and described in the following paragraphs.

**1.3.6.1 S-IV Stage LOX Container.** The S-IV stage LOX Container E152 has a volume of 1262 cu ft; including 4-percent ullage. This gives a capacity of 9,063 gallons. The LOX container is mounted below and is physically separated from the LH<sub>2</sub> container by a honeycombed fiberglass bulkhead faced with aluminum. (See figure 3-4.)

A thermally insulated LOX line, including a flexible bellows section, extends from the bottom of the tank to the RL10A-3 engines.

1.3.6.2 S-IV LOX Tank Pressurization Subsystem. The S-IV LOX tank pressurization subsystem regulates LOX container pressure to maintain a constant LOX pressure head into the RL10A-3 engines during vehicle flight.

#### 1.4 LOX SYSTEM OPERATIONS

LOX system operations are classified as storage operations, transfer operations, and operations involved in the supply of LOX to S-I and S-IV stage propulsion systems. These operations are performed in sequences which are controlled, either directly or indirectly, by control equipment in the LCC. Transfer operations peculiar to either the S-I stage or the S-IV stage are performed in an integrated sequence during a normal countdown, but are described separately for the purpose of clarity.

1.4.1 Modes of Operation - The LOX system is controlled from the LOX control panel located in the LCC. Switches on the control panel permit operation of the system in each of four modes of operation; automatic, semi-automatic, simulate, and manual. Each of these modes of operation is described below.

1.4.1.1 Automatic Mode. The automatic mode of operation is initiated by positioning LOX control panel switches as follows:

- a. The POWER switch is placed in the ON position. This switch controls electrical power to the LOX control panel components.
- b. The four-position FUNCTION SELECTOR switch is placed in the OPERATE position.
- c. The FILL SEQUENCE switch is placed in the AUTO position. This initiates and automatically sequences the following operations.
  1. Main and replenish LOX storage tanks pressurization.
  2. S-IV LOX fill and drain line precool.
  3. S-IV LOX container fast fill.
  4. S-I fill and drain line precool.
  5. S-I LOX tanks fast fill.
  6. LOX replenish lines precool.
  7. S-I LOX replenish.
  8. S-IV LOX replenish.

1.4.1.2 Semi-automatic Mode. The Semi-automatic mode of operation is used mainly for pre-launch system-operation simulation and is initiated from the LOX control panel as follows:

- a. The POWER switch is positioned to the ON position.
- b. The four-position FUNCTION SELECTOR switch is turned to the OPERATE position.
- c. The FILL SEQUENCE switch is turned to the SEMI-AUTO position. At this position the sequence switch transfers semi-automatic control of the LOX system operations to the following switches.
  1. The PRESSURIZE STOR TANKS switch, which initiates pressurization of the main and replenish LOX storage tanks.
  2. The PRECOOL S-IV FILL LINE switch, which initiates the S-IV fill and drain line precool operation.
  3. The MAIN FILL S-IV switch, which initiates the S-IV fast fill operation.
  4. The PRECOOL S-I FILL LINE switch, which initiates the S-I fill and drain line precool operation.
  5. The MAIN FILL S-I fill switch, which initiates the S-I main fill operation and transfers remaining operations to the automatic mode of operation.

1.4.1.3 Simulate Mode. The simulate mode of operation is selected by positioning the FUNCTION SELECTOR switch on the LOX control panel to the SIMULATE position. Operations performed in this mode of operation are identical to those performed in the automatic and semi-automatic modes with one exception; no LOX flow occurs. Manual valves in the transfer line remain closed and the LOX transfer pumps are not operated.

1.4.1.4 Manual Mode. In the manual mode of operation, system components, with the exception of LOX transfer pumps, can be individually operated from the LOX components panel to verify component operation. This mode of operation is selected by positioning the FUNCTION SELECTOR switch on the LOX control panel to the MANUAL position. At the MANUAL position, the switch transfers control power to individual component switches on the LOX components panel.

#### 1.4.2 Storage Operations

1.4.2.1 Storage Tank Filling. LOX for filling main LOX Storage Tank A300 and replenish LOX storage tank A200 is transported to the launch complex in mobile tankers. Approximately 125,000 gallons of LOX are pumped into the main LOX storage tank, and approximately 28,000 gallons are pumped into the replenish storage tank.

Before the main LOX storage tank is filled, the annular space between the tank walls is pressurized to 0.1 psig with dry GN<sub>2</sub>. This is done to prevent the accumulation of moisture in the Pearlite insulation between the walls. Two storage cylinders supply the GN<sub>2</sub>.

In the replenish LOX storage tank, a vacuum is maintained in the space between the tank walls to prevent moisture accumulation. Connections are provided to allow re-evacuation of the space as necessary.

#### 1.4.2.2 Storage Tank Pressurization

- a. Setup. Storage tank pressurization is initiated at the LOX control panel as follows:
  1. The POWER switch is turned to the ON position.
  2. The FUNCTION SELECTOR switch is turned to OPERATE.
  3. The FILL SEQUENCE switch is positioned to AUTO.
- b. Main LOX Storage Tank Pressurization. Main LOX Storage Tank A300 is pressurized with 30-psig GOX from LOX Vaporizer A305. The pressurization sequence occurs as follows:
  1. The main LOX tank pressurization Pneumatic Valve A301 is opened with 750-psig GN<sub>2</sub> from Solenoid Valve A2739.
  2. Storage tank vent Pneumatic Valve A1 is closed by 750-psig GN<sub>2</sub> from Solenoid Valve A2736.
  3. Main LOX tank vaporizer blower Motor A304 is started.
  4. LOX flows from Storage Tank A300 through vaporizer supply Manual Valve A323, main LOX tank pressurization Pneumatic Valve A301, past Relief Valve A321, to Flow Regulator A306.
  5. LOX flows through Flow Regulator A306 and into Vaporizer A305. The fan blows air across the vaporizer coils to effect the LOX to GOX conversion.
  6. Pressurized GOX flows from the vaporizer through vent line shut off Manual Valve A327 and into the storage tank ullage.
  7. As ullage pressure varies from 30 psig, proportional Controller A328 supplies GN<sub>2</sub> control pressure (between 3 and 15 psig) to the flow regulator valve to restore proper ullage pressure.

- b. Replenish LOX Storage Tank Pressurization. Replenish LOX Storage Tank A200 is pressurized with 190-psig GOX from LOX Vaporizer A205. The pressurization sequence occurs as follows:

1. Replenish LOX tank vent Pneumatic Valve A4 is closed with 750-psig GN<sub>2</sub> supplied from Solenoid Valve A2752.
2. LOX Replenish tank pressurization Pneumatic Valve A201 is opened with 750-psig GN<sub>2</sub> supplied from Solenoid Valve A2755.
3. LOX replenish tank vaporizer blower Motor A204 is started.
4. LOX flows from the LOX replenish tank through vaporizer supply Manual Valve A227 and replenish tank pressurization Pneumatic Valve A201 to Flow Regulator A206.
5. LOX flows through Flow Regulator A206 into Vaporizer A205. The vaporizer fan blows air across the coils of the vaporizer to effect the LOX to GOX conversion.
6. Pressurized GOX flows from the vaporizer through the vent line shutoff Manual Valve A220 into the LOX replenish tank ullage.
7. As the pressure in the ullage varies from 190 psig, proportional Controller A235 supplies GN<sub>2</sub> control pressure (between 3 and 15 psig) to Flow Regulator A206 to restore the proper ullage pressure.

1.4.3 Preparation for Vehicle LOX Loading - A manual check of all LOX system components must be conducted and their proper operation verified before either an actual or a simulated loading operation is attempted. Prior to the LOX loading operation the system must be placed in a state of readiness as indicated below.

- a. The following valves must be opened.

1. S-IV fill line Manual Valve A73
2. LOX suction line Manual Valve A307
3. LOX suction line Manual Valve A309
4. LOX return line Manual Valve A310
5. Vaporizer LOX supply line Manual Valve A323
6. Main tank vent line shutoff Manual Valve A327
7. S-I fill line Manual Valve A26

8. S-I replenish line Manual Valve A75
  9. Replenish tank LOX withdrawal Manual Valve A210
  10. Replenish tank vent line shutoff Manual Valve A220
  11. Replenish LOX tank vaporizer LOX supply line Manual Valve A227
- b. The following valves must be closed:
1. LOX drain line Manual Valve A68
  2. S-IV fill line drain Manual Valve A70
  3. S-I fill line drain Manual Valve A71
  4. S-I transfer pump suction line drain Manual Valve A112
  5. S-IV transfer pump suction line drain Manual Valve A113
  6. Main LOX tank vent line drain Manual Valve A133
  7. Main LOX tank trycock Manual Valve A311
  8. Vaporizer by-pass Manual Valves A319 and A320
  9. Replenish LOX tank vent line drain Manual Valve A81
  10. Replenish LOX tank vaporizer by-pass Manual Valves A223 and A224
  11. Replenish LOX tank trycock Manual Valve A230
- c. The following conditions must be fulfilled prior to starting the LOX loading operation:
1. S-I stage LOX tank vents open.
  2. S-I stage LOX prevalues open.
  3. S-I stage 750-psig pneumatic pressure available.
  4. S-I stage LOX tanking computer ready.
  5. Launcher 750- and 25-psig pneumatic pressure available.
  6. S-IV stage pneumatic pressure available.
  7. S-IV stage tower complex pneumatic pressure available.



8. S-IV stage ready for LOX loading.

9. Storage facility 750-psig pneumatic pressure available.

#### 1.4.4 S-IV Stage LOX Transfer Operations

1.4.4.1 S-IV Stage Fill and Drain Line Precool. The S-IV stage LOX fill and drain line precool operation is automatically initiated after the main and replenish LOX storage tanks are pressurized. LOX fill and drain Quick Disconnect Coupling A3160, umbilical line LOX Pneumatic Valve A3151, the S-IV fill-drain and replenish line, and swing arm No. 2 umbilical housing are supplied with a 50-psig GN<sub>2</sub> purge. The purge supply is controlled by Solenoid Valves A2563 and A2561 in valve panel B (volume V). The inert atmosphere maintained by GN<sub>2</sub> in the LOX coupling area minimizes the fire hazard should there be a LOX leak during precool and/or filling operations.

The following operations are performed at the start of S-IV precool.

- a. S-IV LOX container vent and relief Pneumatic Valves E153 and E154 are opened.
- b. S-IV LOX container fill and drain Pneumatic Valve E151 is opened.
- c. Umbilical line LOX Pneumatic Valve A3151 is opened.
- d. Main fill Pneumatic Valve A4005 is opened.
- e. Pump discharge Pneumatic Valve A10 is opened.
- f. Precool drain and vent Pneumatic Valve A148 is opened (timed to close after 5 minutes).
- g. Line vent Pneumatic Valve A13 is closed.
- h. Precool drain and vent Pneumatic Valve A149 is closed.
- i. Umbilical line vent Pneumatic Valve A4023 is closed.
- j. Replenish Throttle Valve A4021 is closed.

Pressurized LOX flows from main LOX Storage Tank A300 through Manual Valve A309 and Strainer A100, past Relief Valve A90, and through Transfer Pump A106 (the pump does not operate during the precool operation). From the transfer pump, LOX flows through pump discharge Pneumatic Valve A10, Check Valve A45, Manual Valve A73, main fill Pneumatic Valve A4005, Strainer A4011, umbilical line LOX Pneumatic Valve A3151, the fill and drain Quick Disconnect Coupling A3160 and E150, fill and drain Pneumatic Valve E151 and into the S-IV stage LOX Container E152. The container is vented through container and relief vent, Pneumatic Valves E153 and E154.

1.4.4.2 S-IV LOX Container Main Fill. The S-IV LOX container main fill operation is initiated immediately after completion of the fill line precool operation. The S-IV LOX Transfer Pump A106 is started and Pressure Switch A436 activates at 150 psi. LOX flows, at 1000 gpm to the LOX container through the same path as that followed during the precool operation. Precool drain and vent Pneumatic Valve A148 is opened when the transfer pump starts, is held open for forty seconds, and is then closed.

A command signal stops the LOX transfer Pump A106 when the S-IV LOX container has been filled to the 98 percent full level as determined by the S-IV propellant utilization system and Douglas Aircraft Company (DAC) propellant loading equipment. The command signal also opens line vent Pneumatic Valve A13, precool drain and vent Pneumatic Valve A148, and starts a fifteen second timer. Fifteen seconds after the LOX level reaches the 98 percent full level, the S-IV fill and drain Pneumatic Valve E151 is closed, main LOX fill Pneumatic Valve A4005 is closed, and umbilical line vent Pneumatic Valve A4023 is opened. S-IV fill and drain Pneumatic Valve E151 and pump discharge Pneumatic Valve A10 are closed. Precool drain and vent Pneumatic Valve A148 is closed and line vent Pneumatic Valve A13 is opened. LOX drains from the fill line and vents overboard through Check Valve A4027.

S-IV replenish line precooling is normally initiated at completion of the S-I stage main LOX fill operation. This action is initiated as follows: replenish line vent Pneumatic Valve A136 is closed, umbilical line vent Pneumatic Valve A4023 is closed, replenish line control Pneumatic Valve A61 is opened, replenish Throttle Valve A4021 is opened, and replenish precool drain and vent Pneumatic Valve A149 is opened. LOX flows, under pressure, from the replenish storage tank through replenish line control Pneumatic Valve A61, Throttle Valve A4021, Strainer A4011, Quick Disconnect Couplings A3160 and E150 and to fill and drain Pneumatic Valve E151. LOX also flows through the replenish precool drain and vent valve and Check Valve A150.

1.4.4.3 S-IV LOX Container Replenish. The S-IV LOX replenish operation is initiated when liquid level sensors in the replenish line are actuated. Replenish precool drain and vent Pneumatic Valve A149 is closed and the S-IV fill and drain Pneumatic Valve E151 is opened.

Pressurized LOX flows from a tee connection in the LOX replenish line (downstream from replenish line control Pneumatic Valve A61) through Manual Valve A75, replenish and throttle Pneumatic Valve A4021, Strainer, A4011, umbilical line LOX Pneumatic Valve A3151, Coupling Assembly A3160, Coupling Half E150, LOX fill and drain Pneumatic Valve E151 and into the S-IV LOX container. GOX is vented from the tank through the S-IV vent valves E153 and E154.

During the replenish operation, the amount of LOX allowed to flow through Throttle Valve A4021 is regulated to maintain the S-IV LOX container level between 99.25 and 99.75 percent of a predetermined full level. The position of Throttle Valve A4021 is controlled by Pneumatic Relay A4026 which is, in turn, controlled by an analog signal from DAC propellant loading equipment. From T-150 seconds to approximately T-50 seconds in the countdown sequence, Throttle Valve A4021 is fully opened. This allows rapid filling of the LOX container to the 100 percent full level. When the LOX container

level probe signals the DAC propellant loading equipment that the LOX container is 100 percent full, the propellant loading equipment generates an analog signal that causes Throttle Valve A4021 to close. Coincident with throttle valve closure, fill and drain Pneumatic Valve E151 is closed and umbilical line drain Pneumatic Valve A4023 is opened. Residual LOX in the upstream portion of the replenish line drains through the umbilical line drain pneumatic valve and is vented to the ground through Check Valve A4027.

At vehicle liftoff, umbilical line LOX Pneumatic Valve A3151 is closed to prevent the release of GOX from Quick Disconnect Coupling A3160 and thereby prevent a fire hazard in the area of the swing arm No. 2 umbilical housing. To further prevent a fire hazard, a 50-psig GN<sub>2</sub> purge is directed into the S-IV fill and replenish line.

1.4.4.4 S-IV LOX Container Drain. The S-IV LOX container can be drained at any time in relation to draining the S-I tanks. Before the S-IV LOX container can be drained, it must be pressurized and Storage Tank A300 must be depressurized. Vent and relief Pneumatic Valves E153 and E154 are closed and the S-IV LOX container is pressurized with 3000-psig GHe from the vehicle control pressure system to start the LOX container drain sequence. After the S-IV LOX container is pressurized, main fill Pneumatic Valve A4005 and LOX fill and drain Pneumatic Valve E151 are opened, and a five-minute timer is started. The timer provides five minutes for main LOX storage tank depressurization before drain operation initiation. The main LOX storage tank is depressurized as follows: Vent Valve A1 is opened, main LOX tank pressurization Pneumatic Valve A301 is closed, and vaporizer blower Motor A304 is stopped.

Five minutes after pressurization of the S-IV LOX container, upper stage line drain Pneumatic Valve A22 is opened by a signal from the timer. Pressurized LOX flows from the S-IV LOX container through LOX fill and drain Pneumatic Valve E151, Quick Disconnect Coupling E150, Quick Disconnect Coupling A3160, umbilical line LOX Pneumatic Valve A3151, Strainer, A4011, main fill Pneumatic Valve A4005, Manual Valve A73, drain Pneumatic Valve A22, Check Valve A30, Manual Valve A310 and into the main LOX storage tank. S-IV LOX drain is terminated by the closing of fill and drain Pneumatic Valve E151, main fill Pneumatic Valve A4005 and drain Pneumatic Valve A22. Drain and vent Pneumatic Valve A148 and upper stage line vent Pneumatic Valve A13 are opened to vent the main fill and replenish lines and are later closed.

#### 1.4.5 S-I Stage LOX Transfer Operations

1.4.5.1 S-I Fill and Drain Line Precool. The S-I Stage fill and drain line precool operation occurs as follows: pump discharge Pneumatic Valve A7 is opened, main LOX fill and drain Pneumatic Valve A31 is opened, main LOX fill and drain Pneumatic Valve B152 is opened. Line drain Pneumatic Valve A16 is closed, and mast drain Pneumatic Valve A34 is closed. Pressure in the main LOX storage tank causes LOX flow from the storage tank through Manual Valve A307, Strainer A99, LOX Transfer Pump A105 (pump does not operate during precool), pump discharge Pneumatic Valve A7, Check Valve A115, Manual Valve A26, main LOX fill Pneumatic Valve A31, Retractable Coupling A4600, Nozzle B153, main LOX fill and drain Pneumatic Valve

B152 and into LOX tank O-3. LOX flows to the other S-I LOX tanks through the lower LOX tank interconnecting manifold.

1.4.5.2 S-I LOX Main Fill. Upon completion of the S-I fill and drain line precool operation, the main fill operation is initiated by starting Transfer Pump A105. The transfer pump provides a 2500 gpm LOX flow to the S-I stage LOX tanks through the same flowpath used in the fill and drain line precool operation. Transfer pump operation is verified throughout the operation by Pressure Switch A435. When the transfer pump discharge pressure reaches 165 psig, the switch actuates and transmits a signal to LCC LOX control equipment.

The S-I LOX main fill operation continues until the LOX tanking computer senses that the S-I stage LOX tanks are 95 percent filled. At this point in the operation, the tanking computer generates a command signal that starts a 15-second timer and initiates the following: LOX Transfer Pump A105 is stopped; main LOX fill and drain Pneumatic Valve B152 is closed; throttle bypass Pneumatic Valve A52 is closed; S-I stage line drain Pneumatic Valve A19 is opened, and S-I line vent Pneumatic Valve A16 is opened. When the 15-second timer expires, mast drain Pneumatic Valve A34 is opened; main LOX fill and drain Pneumatic Valve A31 is closed, and pump discharge Pneumatic Valve A7 is closed. Residual LOX in the transfer line is vented through Pneumatic Valve A34 and Check Valve A85 as well as through Pneumatic Valve A16 and Check Valve A76.

1.4.5.3 S-I Replenish Line Precool. The S-I replenish line precool operation is performed during the S-I main fill operation in order to permit the S-I LOX replenish operation to be initiated immediately upon termination of the main fill operation. When the S-I stage LOX tanks are 75 percent filled, the LOX tanking computer initiates the replenish line precool operation as follows: S-I replenish Pneumatic Valve B151 is opened; replenish throttle control Pneumatic Valve A55 and replenish throttle bypass Pneumatic Valve A52 are opened; replenish line control Pneumatic Valve A61 is opened; S-I replenish line drain Pneumatic Valve A143 is closed, and replenish line vent Pneumatic Valve A136 is closed. LOX flows from Replenish Storage Tank A200 through Manual Valve A210, replenish control Pneumatic Valve A61, Manual Valve A75, replenish throttle Pneumatic Valve A55 and replenish throttle bypass Pneumatic Valve A52, Coupling A430 and Weldment Coupling B150, replenish Pneumatic Valve B151 and into LOX tank O-4.

1.4.5.4 S-I LOX Replenish. At termination of the S-I main fill operation, the S-I stage LOX tanks are replenished with LOX from Replenish Storage Tank A200 and are maintained at the 100 percent full level by LOX Tanking Computer A83 and replenish throttle Pneumatic Valve A55. LOX flow to the S-I stage LOX tanks follows the flow path used in the S-I replenish line precool operation with one exception; throttle bypass Pneumatic Valve A52 is closed. The replenish operation continues until T-150 seconds in the countdown sequence and is terminated by the following actions:

- a. S-I LOX replenish Pneumatic Valve B151 is closed.
- b. Replenish throttle control Pneumatic Valve A55 is closed.

- c. Replenish line drain Pneumatic Valve A143 is opened.
- d. Residual LOX in the replenish line drains through replenish line drain Pneumatic Valve A143 and Check Valve A96.

1.4.5.5 S-I LOX Tanks Drain. The S-I LOX tanks can be drained before or after S-IV stage LOX container is drained. To initiate the S-I LOX tank drain operation a five-minute timer is started, mast drain Pneumatic Valve A34 is closed, vent and relief Pneumatic Valves B171-1, B171-2, and B172 are opened, fill and drain Pneumatic Valve B152 is opened, and main LOX fill and drain Pneumatic Valve A31 is opened. Unless previously accomplished, the main LOX storage tank is depressurized while the five-minute timer is running. When the five minute timer expires, it initiates a signal that causes the S-I line drain Pneumatic Valve to open. LOX flows from the S-I stage LOX tanks through the lower LOX tank interconnecting manifold to LOX tank O-3, through fill and drain Pneumatic Valve B152, Nozzle B153 and Retractable Coupling A4600, fill and drain Pneumatic Valve A31, Manual Valve A26, line drain Pneumatic Valve A19, Check Valve A30 and Manual Valve A310 into the LOX storage tank.

S-I LOX drain is terminated by the closure of fill and drain Pneumatic Valve B152, fill and drain Pneumatic Valve A31 and line drain Pneumatic Valve A19. Pneumatic Valves A34 and A16 are opened to drain and vent the transfer lines.

1.4.6 S-I Stage LOX Utilization - S-I Stage LOX utilization operations include: a pre-flight bubbling of LOX in the S-I stage LOX tanks, S-I stage LOX tank pressurization, prevolve operation, and inboard and outboard engine cutoff.

1.4.6.1 LOX Bubbling. During S-I stage LOX filling operations, and prior to LOX tank pressurization, the S-I stage LOX tanks and suction lines are bubbled with gaseous helium. This pre-flight bubbling prevents LOX temperature stratification in the LOX tanks and suction lines and thereby prevents cavitation in engine suction pumps and reduces LOX boiloff.

The  $\text{GH}_e$  supply is routed from valve panel No. 10 at 350 psig and is coupled into the S-I stage through short cable mast No. 4 and Quick Disconnect Couplings A6610 and B450. Within the stage, the  $\text{GH}_e$  supply is distributed to each suction line through individual branch lines that extend from a common ring manifold. Helium flow into each suction line is reduced at 70 scfm by Orifices B451. After the  $\text{GH}_e$  bubbles through the suction lines and the LOX tanks, it is vented to the atmosphere through vent Pneumatic Valves B171-1, B171-2, and B172.

1.4.6.2 LOX Tank Pressurization. The S-I stage LOX tanks are pressurized to provide the required inlet pressure to the H-1 engine LOX turbopumps. Prelaunch pressurization of the tanks is provided by a  $\text{GH}_e$  source from valve panel No. 10, and in-flight pressurization is provided by GOX from the H-1 engine heat exchangers.

- a. Preflight Pressurization. Preflight pressurization of the LOX tanks begins at termination of the LOX bubbling operation. Vent and relief Pneumatic Valves B171-1 and B171-2 and LOX vent Pneumatic Valve 172 are closed by

deenergizing Solenoid Valves B215 and B222. From valve panel No. 10 a 3000-psig  $\text{GH}_e$  source is routed through the launcher and is coupled into the stage through short cable mast No. 2 and quick disconnect Couplings A6508 and B385. From Coupling Half B385  $\text{GH}_e$  flows through Check Valve B387 and into LOX tank O-C. The pressurization supply is equally distributed from LOX tank O-C to the outer LOX tanks through lines that interconnect the ullage areas of the tanks. When pressure in the LOX tanks reaches 59.5 psia, Pressure Switch B167 actuates and initiates a signal that terminates the  $\text{GH}_e$  supply. If Pressure Switch B167 fails, Pressure Switch B169 provides overpressure protection for the tanks. Should the LOX tank pressure reach 68 psia, Pressure Switch B169 actuates and initiates a command signal that opens Solenoid Valve B215. When Solenoid Valve B215 opens, LOX vent Pneumatic Valve B172 and vent and relief Pneumatic Valves B171-1 and B171-2 are opened, and LOX tank pressure is released to the atmosphere. Control of the  $\text{GH}_e$  pressurization supply by Pressure Switch B167 continues until vehicle liftoff. At liftoff, the  $\text{GH}_e$  supply is terminated by a signal from the vehicle liftoff switches.

- b. In-flight Pressurization. Two LOX tank pressurization supplies are available during the period between engine ignition and vehicle liftoff; a GOX supply from the H-1 engine heat exchangers and  $\text{GH}_e$  from valve panel No. 10.

In-flight pressurization is maintained by GOX produced by LOX vaporization in the H-1 engine heat exchangers. GOX from the heat exchangers flows into a common manifold, through flow control regulator Pneumatic Valve B170 and into LOX tank O-C. The outer LOX tanks receive GOX through upper interconnecting lines from tank O-C. The pneumatic flow control valve senses LOX tank O-C ullage pressure and controls the flow of GOX to the tanks to maintain a pressure of approximately 60 psia. Vent and relief valves provide protection against overpressurization.

1.4.6.3 H-1 Engine Operation and Cutoff. Each outer LOX tank supplies LOX to one inboard engine and one outboard engine. The LOX flows into two suction lines, through Pneumatic Valves (prevalves) B155, and to the inlet side of the H-1 engine turbopumps. Two seconds after the fuel level in either tank F-2 or F-4 falls below cutoff Liquid Level Sensors B104 (volume I) or the LOX level in LOX tanks O-2 or O-4 falls below Liquid Level Sensors B161-1 or B161-2, the flight computer initiates a signal that fires the inboard engine conax valves. The outboard engines are normally shut down by a six-second timer that is initiated at inboard engine cutoff. However, the engines will be shut down before the timer expires if either of the following actions occurs: the outboard engine thrust OK pressure switches deactuate due to LOX depletion, or the fuel level falls below fuel depletion liquid level sensors in the sumps of fuel tanks F-2 and F-4.

1.4.6.4 LOX Prevalve Operation. Pneumatic Valves (prevalves) B155 are normally closed shutoff valves that control LOX flow to the H-1 engines. One pre valve is provided for each H-1 engine. The prevalves are held open during LOX tank filling operations and engine operation and are closed as part of the normal H-1 engine cutoff

sequence. A 750-psig GN<sub>2</sub> control pressure supply is routed from distribution Manifold B211 (volume V) through Solenoid Valves B217 (one for each pre valve) for pre valve operation. Because each pre valve is individually controlled by a Solenoid Valve B217, the pre valves may be operated singularly or in any combination.

In the event of individual engine failure during flight, the dead-engine conax valve signals the appropriate Solenoid Valve B217 to close the dead-engine Pneumatic Valve B155, thus shutting off the LOX supply to the dead engine. The LOX tank interconnecting manifold then equally distributes the dead-engine LOX supply to the other engines.

1.4.7 S-IV Stage LOX Utilization - S-IV Stage LOX utilization operations include a pre-flight bubbling of LOX in the S-IV stage LOX container, a LOX container pressurization sequence, and LOX consumption.

1.4.7.1 LOX Bubbling. The S-IV stage LOX suction lines are bubbled with a cold helium supply from valve panel B. The purpose of this bubbling operation is to prevent LOX temperature stratification in the LOX container. Bubbling is initiated at approximately T-450 seconds in the countdown and is continued until T-150 seconds. The operation is initiated by a command signal that opens Solenoid Valves E166 and E167. Cold GH<sub>e</sub> flows from valve panel B into the vehicle through Quick Disconnect Coupling A3157 and E225, Solenoid Valve E167, Filter E168, Orifice E169 and into a manifold. From the manifold GH<sub>e</sub> is routed to each suction line through Check Valve E171 and Orifice E172. Helium also flows through Solenoid Valve E166, past Thermal Switch E162, through Orifice E163 and is vented overboard. After approximately five minutes, bubbling is terminated by deenergizing Solenoid Valve E166 and E167.

1.4.7.2 LOX Container Pressurization. LOX container E152 is pressurized to approximately 47.0 psia with cold GH<sub>e</sub> from valve panel B. The container is pressurized during flight from three helium storage spheres located in the LH<sub>2</sub> container. Helium from the spheres is routed to the LOX container through Helium Heater E241 which burns LH<sub>2</sub> and LOX supplied from the S-IV propellant tank.

Pressurization is initiated at T-150 seconds in the countdown sequence. The S-IV LOX container vent Pneumatic Valves E153 and E154 are closed by deenergizing Solenoid Valves E214 and E212. Five seconds later, Solenoid Valve E213 is energized to boost close the LOX container vent valves. When the vent valves close there is less than 4.5 psia in the LOX container and Pressure Switch E283 is deactuated, keeping Solenoid Valve E236 open. Cold GH<sub>e</sub> flows from valve panel B and into the vehicle through Coupling Halves A3157 and E225, Check Valve E226, Filter E228, Solenoid Valve E236, Helium Heater E241 (not in operation), Orifice E240 and into the LOX container. When the pressure in the LOX container reaches 47.0 psia, Pressure Switch E283 actuates and closes Solenoid Valve E236. Pressure Switch E281 actuates at 44 psia and provides a monitor for minimum liftoff pressure. Pressure Switch E280 actuates at 52 psia to provide overpressure protection.

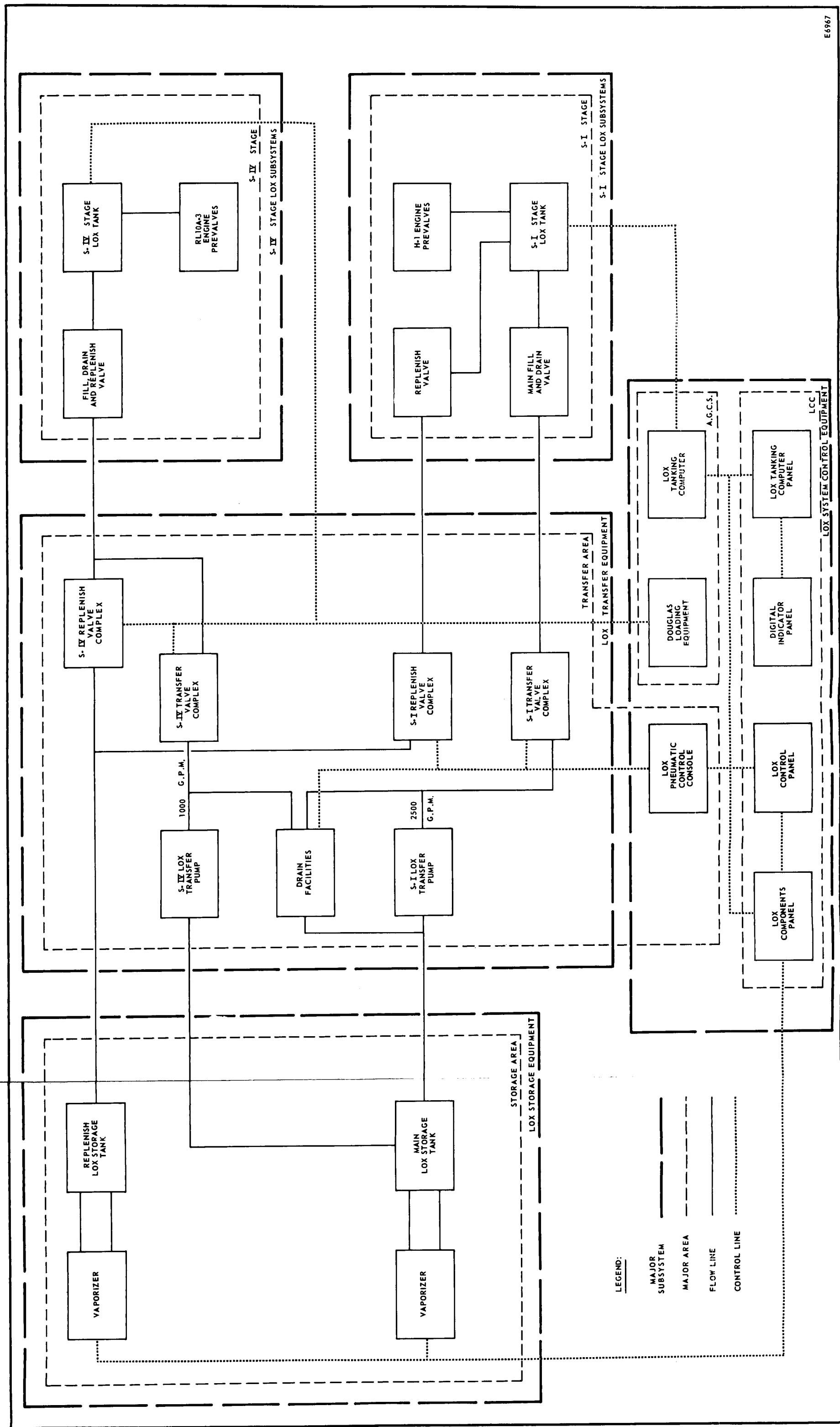
During S-I stage flight, cold  $\text{GH}_e$  is supplied from Storage Spheres E233, E234 and E235 to pressurize the S-IV LOX container. When pressure in the container drops below 45.0 psia Pressure Switch E283 drops out and allows Solenoid Valve E236 to open. Cold  $\text{GH}_e$  flows from the spheres through Filter E230, Regulator E229, Solenoid Valve E236, Helium Heater E241 (not in operation), Orifice E240 and into the LOX container. Container pressure again reaches 47 psia, Pressure Switch E283 actuates and causes Solenoid Valve E236 to close.

Pressurization of the LOX container during S-IV stage operation is obtained from Helium Heater E241. At a predetermined time after S-I/S-IV separation, LOX Electropneumatic Valve E216 is opened,  $\text{LH}_2$  Electropneumatic Valve E215 is opened and Igniters E242 and E244 are energized. LOX and  $\text{LH}_2$  are burned in the combustion chamber of the heater and the gases are exhausted overboard. Thermal Switch E246 provides a monitor for the heater. If heater temperature drops to  $110 (\pm 10)$  F, the thermal switch signals LOX Electropneumatic Valve E216 and  $\text{LH}_2$  Electropneumatic Valve E215 to close.

Cold  $\text{GH}_e$  is supplied to the heater from Spheres E233, E234 and E235 through the same path followed during S-I stage flight. When the command is given to open  $\text{LH}_2$  Electropneumatic Valve E215, the control for Solenoid Valve E236 is transferred from Pressure Switch E283 to Pressure Switch E237, and the control of Solenoid Valve E238 is transferred to Pressure Switch E237. When pressure in the plenum chamber is raised to 330 psia, Pressure Switch E237 picks up and causes Solenoid Valve E236 to close. If pressure in the LOX container drops to 45.0 psia, Pressure Switch E283 deactuates and opens Solenoid Valve E238. This allows  $\text{GH}_e$  to flow through the secondary coil of the heater, thereby increasing  $\text{GH}_e$  flow into the LOX container. When pressure in the container again reaches 47.0 psia, Pressure Switch E283 actuates and closes Electropneumatic Valve E238.

1.4.7.3 LOX Consumption. LOX consumption begins during RL10A-3 engine cool-down and terminates at engine cutoff. During engine operation, LOX flows from the LOX container to the six engines through six suction lines. Shutoff valves in each suction line control LOX flow into engine turbopumps. Engine operation is terminated by either LOX depletion or  $\text{LH}_2$  depletion. When  $\text{LH}_2$  or LOX depletes to a predetermined level, the  $\text{LH}_2$  and LOX shutoff valves are closed and engine cutoff occurs.





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Figure 1-1. Launch Vehicle SA-8 and Launch Complex 37B LOX System Block Diagram  
1.21

## SECTION 2

### INDEX OF FINDING NUMBERS

This section contains an alpha-numerical list, by finding number, of LOX system components that function during a prelaunch countdown, during vehicle flight, or in the event of a launch abort. The finding numbers listed identify components on system schematic diagrams provided in section III. Additional columns in the index of finding numbers provide such pertinent information as component description and function, part number, and the supplier's name and part number. A break will occur in the alpha-numeric sequence of finding numbers when a component, or component series is: non-functional during the countdown; functional only in the event of a malfunction; functional in terms of a maintenance operation only; or part of another functional system.

The letter prefix of a finding number identifies a component with either the launch complex or an area of the launch vehicle. The area associated with each prefix is noted below.

<u>FINDING NUMBER PREFIX</u>	<u>DESIGNATED AREA</u>
A	Ground Support components
B	S-I stage components
E	S-IV stage components
G	Instrument Unit
H	Payload

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A1	1	Valve, Pneumatic	6 in., main storage tank vent	Hydromatics, Inc.	10427400	51A15
A2 and A3	are not	functionally applicable to this system.				
A4	1	Valve, Pneumatic	4 in., replenish storage tank vent	Hydromatics, Inc.	10427321	51A39
A5 and A6	are not	functionally applicable to this system.				
A7	1	Valve, Pneumatic	6 in., S-I pump discharge	Hydromatics, Inc.	10427325	51A21
A8 and A9	are not	functionally applicable to this system.				
A10	1	Valve, Pneumatic	4 in., S-IV pump discharge	Hydromatics, Inc.	10427324	51A20
A11 and A12	are not	functionally applicable to this system.				
A13	1	Valve, Pneumatic	4 in., S-IV fill line vent	Hydromatics, Inc.	10427321	51A33
A14 and A15	are not	functionally applicable to this system.				
A16	1	Valve, Pneumatic	4 in., S-I fill line vent	Hydromatics, Inc.	10427321	51A24
A17 and A18	are not	functionally applicable to this system.				

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A19	1	Valve, Pneumatic	6 in., S-I fill line drain	Hydromatics, Inc.	10427325	51A27
A20 and A21	are not functionally applicable to this system.					
A22	1	Valve, Pneumatic	6 in., S-IV fill line drain	Hydromatics, Inc.	10427325	51A36
A23 through A25	are not functionally applicable to this system.					
A26	1	Valve, Manual	8 in., S-I main fill line	Wm. Powell Co.	10427454	
A27 through A29	are not functionally applicable to this system.					
A30	1	Valve, Check	6 in., vehicle drain	Wm. Powell Co.	10427332	
A31	1	Valve, Pneumatic	6 in., S-I LOX fill and drain	Hydromatics, Inc.	10427325	53A17
A32 and A33	are not functionally applicable to this system.					
A34	1	Valve, Pneumatic	2 in., S-I mast drain	Hydromatics, Inc.	10427346	53A14
A35 through A42	are not functionally applicable to this system.					
A43	1	Valve, Relief	1-1/2 in., 300 psig; S-IV fill line	Gardner Johnson & Co. P/N 1192	10427327	

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A44	1	Valve, Relief	1-1/2 in., 300 psig; S-IV fill line	Gardner Johnson & Co. P/N 1192	10427327	
A45	1	Valve, Check	4 in., S-IV pump discharge line	Wm. Powell Co.	10427322	
A46	is not functionally applicable to this system.					
A47	1	Valve, Relief	1-1/2 in., 300 psig; S-IV fill line	Gardner Johnson & Co. P/N 1192	10427327	
A48 through A51	are not functionally applicable to this system.					
A52	1	Valve, Pneumatic	3 in., S-I replenish throttle valve bypass	Hydromatics, Inc.	10427347	53A8
A53 and A54	are not functionally applicable to this system.					
A55	1	Valve, Pneumatic	2 in., replenish throttle control	Annin Co. Model 1560	10427336	53A4
A56 and A57	are not functionally applicable to this system.					
A58	1	Converter, Pneumatic	Component of tanking computer system	Servomechanism, Inc. P/N 812089	10434805	53A3
A59 and A60	are not functionally applicable to this system.					
A61	1	Valve, Pneumatic	3 in., replenish line control		10427347	51A48

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A62 through A67		are not functionally applicable to this system.				
A68	1	Valve, Manual	1 in., S-I and S-IV fill line drain	Wm. Powell Co.	10427343	
A69		is not functionally applicable to this system.				
A70	1	Valve, Manual	1 in., S-IV fill line drain	Wm. Powell Co.	10427342	
A71	1	Valve, Manual	1 in., S-I pump discharge line drain		10427342	
A72		is not functionally applicable to this system.				
A73	1	Valve, Manual	6 in., S-IV fill and drain line shutoff	Wm. Powell Co.	10427453	
A74		is not functionally applicable to this system.				
A75	1	Valve, Manual	3 in., replenish line shutoff	Wm. Powell Co.	10427340	
A76	1	Valve, Check	4 in., S-I fill line drain vent	Wm. Powell Co.	10427322	
A77		is not functionally applicable to this system.				
A78	1	Valve, Check	4 in., replenish tank check vent	Wm. Powell Co.	10427322	

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A79	1	Valve, Check	6 in., main storage tank vent check		1047332	
A80		is not functionally applicable to this system.				
A81	1	Valve, Manual	1 in., replenish storage tank vent line drain		10427343	
A82		is not functionally applicable to this system.				
A83	1	Computer, LOX Tanking	Component of tanking computer system		10434613	
A84	1	Valve, Relief	1 in., 300 psig; S-I replenish line	Aervalco Model 5530 Part of 10427331	10427331	
A85	1	Valve, Check	2 in., S-I mast drain check	Wm. Powell Co.	10427339	
A86		is not functionally applicable to this system.				
A87	1	Valve, Relief	1 in., 300 psig; S-I replenish line	Ladewig Valve Co. P/N 1178-C	10427320	
A88	1	Valve, Relief	1 in., 75 psig; S-I pump suction line	Gardner Johnson & Co. P/N 1191	10427326	
A89	1	Valve, Relief	1 in., 75 psig; main storage tank liquid return	Gardner Johnson & Co. P/N 1191	10427326	
A90	1	Valve, Relief	1 in., 75 psig; S-IV pump suction line	Gardner Johnson & Co. P/N 1191	10427326	

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A91 and A92	are not functionally applicable to this system.					
A93	1	Valve, Relief	1 in., 300 psig; S-IV fill line drain	Ladewig Valve Co. P/N 1178-C	10427320	
A94	1	Valve, Relief	1 in., 300 psig; S-I fill line drain	Ladewig Valve Co. P/N 1178-C	10427320	
A95	1	Valve, Relief	1 in., 300 psig; replenish line	Ladewig Valve Co. P/N 1178-C	10427320	
A96	1	Valve, Check	2 in., S-I replenish line drain		10427339	
A97	is not functionally applicable to this system.					
A98	1	Valve, Relief	1-1/2 in., 300 psig; S-IV fill line	Ladewig Valve Co. P/N 11160-C	10427327	
A99	1	Strainer	8 in., 2500 gpm, 150 micron; S-I pump suction	Leslie Co.	10427337	
A100	1	Strainer	6 in., 1000 gpm, 150 micron; S-IV pump suction line	Leslie Co.	10427323	
A101	is not functionally applicable to this system.					
A102	1	Strainer	3 in., 500 gpm, 150 micron; S-I replenish line	Leslie Co.	10427334	
A103 and A104	are not functionally applicable to this system.					



Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A105	1	Pump, Transfer	2500 gpm, 350 hp; S-I LOX transfer	Byron Jackson Pump, Inc. P/N 354658	10427328	51A5
A106	1	Pump, Transfer	1000 gpm, 200 hp; S-IV LOX transfer	Byron Jackson Pump, Inc.	10427329	51A6
A107 through A109		are not functionally applicable to this system.				
A110	1	Valve, Relief	1-1/2 in., 300 psig; S-I fill line	Gardner Johnson & Co. P/N 1192	10427327	
A111		is not functionally applicable to this system.				
A112	1	Valve, Manual	1 in., S-I pump suction line drain	Wm. Powell Co.	10427343	
A113	1	Valve, Manual	1 in., S-IV pump suction line drain	Wm. Powell Co.	10427343	
A114	1	Valve, Check	2 in., S-I/S-IV fill line drain	Wm. Powell Co.	10427339	
A115	1	Valve, Check	6 in., S-I pump discharge line	Wm. Powell Co.	10427332	
A116 through A132		are not functionally applicable to this system.				
A133	1	Valve, Manual	1 in., main storage tank vent line drain	Wm. Powell Co.	10427343	
A134 and A135		are not functionally applicable to this system.				

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A136	1	Valve, Pneumatic	1 in., replenish line vent	Hydromatics, Inc.	10427345	53A11
A137 and A138		are not functionally applicable to this system.				
A139	1	Valve, Relief	1-1/2 in., 300 psig; S-I fill line	Gardner Johnson & Co. P/N 1192	10427327	
A140	1	Valve, Relief	1-1/2 in., 300 psig; S-I fill line	Gardner Johnson & Co. P/N 1192	10427327	
A141	1	Valve, Relief	1-1/2 in., 300 psig; S-I fill line	Gardner Johnson & Co. P/N 1192	10427327	
A142	1	Valve, Relief	1 in., 300 psig; S-I mast drain line	Ladewig Valve Co. P/N 1178-C	10427320	
A143	1	Valve, Pneumatic	2 in., S-I replenish line drain	Hydromatics, Inc.	10427346	51A45
A144 and A145		are not functionally applicable to this system.				
A146	1	Valve, Relief	1 in., 300 psig; replenish line	Aervalco Model 5530 Part of 10427331	10427331	
A147	1	Valve, Relief	1 in., 300 psig; replenish line	Aervalco Model 5530 Part of 10427331	10427331	
A148	1	Valve, Pneumatic	4 in., S-IV precool drain and vent	Hydromatics, Inc.	10427324	
A149	1	Valve, Pneumatic	3 in., S-IV precool drain and vent	Hydromatics, Inc.	10427347	

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A150	1	Valve, Check	4 in., S-IV precool drain and vent line	Wm. Powell Co.	10427332	
A151	1	Valve, Solenoid	NC, S-IV precool line valve closing control	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	
A152	1	Valve, Solenoid	N.O., S-IV precool line valve opening control	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	
A153	1	Valve, Solenoid	NC, S-IV precool line valve closing control	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	
A154	1	Valve, Solenoid	N.O., S-IV precool line valve opening control	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	
A155 through A199			are not functionally applicable to this system.			
A200	1	Tank, Storage	28,000 gallons, LOX replenish	Chicago Bridge & Iron Co.	10427472	
A201	1	Valve, Pneumatic	3 in., replenish storage tank pressurization	Hydromatics, Inc.	10427347	51A42
A202 and A203			are not functionally applicable to this system.			
A204	1	Motor	15 hp, 1750 rpm; replenish storage tank vaporizer		10466648	51A8
A205	1	Vaporizer	Replenish storage tank pressurization	Chicago Bridge & Iron Co.	10427318	
A206	1	Regulator, Flow	2 in.	Annin Co. Model 1660	10427335	

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A207 through A209			are not functionally applicable to this system.			
A210	1	Valve, Manual	3 in., replenish line shutoff	Wm. Powell Co.	10427472	
A211 through A219			are not functionally applicable to this system.			
A220	1	Valve, Manual	6 in., replenish storage tank pressurizing shutoff	Wm. Powell Co.	10427472	
A221	1	Valve, Relief	3 in. by 4 in., 205 psig	Kunkle Valve Co. Part of 10427472	10427472	
A222			is not functionally applicable to this system.			
A223	1	Valve, Manual	3 in., vaporizer by-pass	Wm. Powell Co.	10427340	
A224	1	Valve, Manual	3 in., vaporizer by-pass	Wm. Powell Co.	10427340	
A225	1	Valve, Relief	1 in., 300 psig; replenish tank pressurizing	Ladewig Valve Co. P/N 1178-C	10427320	
A226	1	Valve, Relief	1 in., 300 psig; replenish tank pressurizing	Ladewig Valve Co. P/N 1178-C	10427320	
A227	1	Valve, Manual	4 in., replenish tank pressurizing shutoff	Wm. Powell Co.	10427472	
A228 and A229			are not functionally applicable to this system.			

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A230	1	Valve, Manual	1 in., replenish tank liquid level trycock	Wm. Powell Co.	10427342	
A231 through A234		are not functionally applicable to this system.				
A235	1	Controller	Output press. 3-15 psi, supply press. 25 psi, sensing press. range 0-300 psi	Mason-Neilan Model 2707	10427402	
A236 through A299		are not functionally applicable to this system.				
A300	1	Tank, Storage	125, 000 gallon, LOX	Chicago Bridge and Iron Co.	10427471	
A301	1	Valve, Pneumatic	3 in., main storage tank pressurization	Hydromatics Inc.	10427347	51A18
A302 and A303		are not functionally applicable to this system.				
A304	1	Motor	15 hp, 1750 rpm, main storage tank vaporizer		10466648	51A7
A305	1	Vaporizer	Main storage tank pressurization	Chicago Bridge and Iron Co.	10427318	
A306	1	Regulator, Flow	2 in.	Annin Co. Model 1660	10427335	
A307	1	Valve, Manual	8 in., S-I fill shutoff	Wm. Powell Co.	10427471	
A308 is not		functionally applicable to this system				

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A309	1	Valve, Manual	6 in., S-IV fill shutoff	Wm. Powell Co.	10427453	
A310	1	Valve, Manual	6 in., main storage tank liquid return	Wm. Powell Co.	10427453	
A311	1	Valve, Manual	1 in., main storage tank liquid level trycock	Wm. Powell Co.	10427343	
A312 through A316		are not functionally applicable to this system.				
A317	1	Valve, Relief	45 psig, main storage tank pressurization	J. E. Lonegran Co. Model 41W 209M	10427471	
A318		is not functionally applicable to this system.				
A319	1	Valve, Manual	3 in., vaporizer by-pass	Wm. Powell Co.	10427341	
A320	1	Valve, Manual	3 in., vaporizer by-pass	Wm. Powell Co.	10427341	
A321	1	Valve, Relief	1 in., 75 psig; main tank pressurizing	Gardner Johnson & Co. P/N 1191	10427326	
A322	1	Valve, Relief	1 in., 75 psig; main tank pressurizing	Gardner Johnson & Co. P/N 1191	10427326	
A323	1	Valve, Manual	4 in., main storage tank pressurization shutoff	Wm. Powell Co.	10427471	
A324 through A326		are not functionally applicable to this system.				

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A327	1	Valve, Manual	6 in., main storage tank pressurization shutoff	Wm. Powell Co.	10427471	
A328	1	Controller	25 psi supply press., 3-15 psi output press., 0-40 psi sensing press. range	Mason Neilan Model 2707	10427403	
A329 through A341		are not functionally applicable to this system.				
A342	1	Valve, Vacuum Relief	6 in., 0.030 psig vacuum	Oeco Model T Part of 10427471	10427471	
A343 through A429		are not functionally applicable to this system.				
A430	1	Coupling	3 in., S-I replenish line	NASA	75M03191	
A431 through A2699		are not functionally applicable to this system.				
A2700	1	Gage, Pressure	0-10000 psi range, 3000 psi supply	U. S. Gage Co.	10437648	
A2701	1	Gage, Pressure	0-1500 psi range, 750 psi discharge	U. S. Gage Co.	10437688	
A2702	1	Gage, Pressure	0-300 psi range, 120 psi supply	U. S. Gage Co.	10437687	
A2703	1	Gage, Pressure	0-60 psi range, 25 psi discharge	U. S. Gage Co.	10437686	

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A2704	1	Regulator, Pressure	3/8 in.; 3000 psi input, 750 psi output	Grove Valve & Reg. Co. Model 94X	10437651	
A2705	1	Regulator, Pressure	3/8 in.; 750 psi input, 120 psi output	Grove Valve & Reg. Co. Model 94X	10437651	
A2706	1	Valve, Regulator	120 psi input, 25 psi output	Moore Products Co. Model 42H50	10437679	
A2707	1	Filter	10 micron, 3000 psi supply line	Permanent Filter Co. P/N 10813	10437650	
A2708	1	Valve, Relief	900 ( $\pm 50$ ) psig relief, 750 psig min. reseal	Republic Mfg. Co. P/N 625B-9-6	10437652	
A2709	1	Valve, Relief	120 ( $\pm 10$ ) psig relief, 100 psig min. reseal	Republic Mfg. Co. P/N 625B-3-6	10437680	
A2710	1	Valve, Relief	35 ( $\pm 5$ ) psig relief, 25 psig min. reseal	Republic Mfg. Co. P/N 625B-2-8	10437681	
A2711	1	Switch, Pressure	Act. 21.5 ( $\pm 0.5$ ) psig rising press., deact. 1.5 psi diff. pressure	Southwest Industries P/N 3700 A-4	10437682	
A2712	1	Valve, Manual	Shutoff	Robbins Aviation P/N SSNA-375A-6T	10437684	
A2713	1	Valve, Manual	Shutoff	Robbins Aviation P/N SSNA-375A-6T	10437684	
A2714	1	Valve, Manual	Shutoff	Robbins Aviation P/N SSNA-375A-6T	10437684	
A2715	1	Valve, Manual	Shutoff	Robbins Aviation P/N SSNA-375A-6T	10437684	



Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A2716	1	Valve, Manual	Vent	Futurecraft Corp. P/N 30205	10437647	
A2717	1	Valve, Manual	Vent	Futurecraft Corp. P/N 30205	10437647	
A2718	1	Valve, Manual	Vent	Futurecraft Corp. P/N 30205	10437647	
A2719	1	Valve, Manual	Vent	Futurecraft Corp. P/N 30205	10437647	
A2720	1	Valve, Manual	Shutoff	Robbins Aviation P/N SSNA-375A-6T	10437684	
A2721	1	Valve, Manual	Vent	Futurecraft Corp. P/N 30205	10437647	
A2722	1	Valve, Manual	Vent	Futurecraft Corp. P/N 30205	10437647	
A2723	1	Valve, Manual	Vent	Futurecraft Corp. P/N 30205	10437647	
A2724	1	Valve, Manual	Vent	Futurecraft Corp. P/N 30205	10437647	
A2725	1	Switch, Pressure	Act. 600 ( $\pm$ 20 ) psig rising press, 50 psi diff. press	Southwestern Industries, Inc. P/N PS-5100A	10437683	
A2726	1	Valve, Manual	Shutoff	Robbins Aviation P/N SSNA-250-4T	10437685	
A2727	1	Valve, Manual	Shutoff	Robbins Aviation P/N SSNA-250-4T	10437685	

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A2728	1	Valve, Manual	Shutoff	Robbins Aviation P/N SSNA-250-4T	10437685	
A2729	1	Valve, Manual	Shutoff	Robbins Aviation P/N SSNA-250-4T	10437685	
A2730	1	Valve, Manual	Vent	Futurecraft Corp. P/N 30205	10437647	
A2731	1	Valve, Manual	Vent	Futurecraft Corp. P/N 30205	10437647	
A2732	1	Valve, Manual	Vent	Futurecraft Corp. P/N 30205	10437647	
A2733	1	Valve, Manual	Vent	Futurecraft Corp. P/N 30205	10437647	
A2734	1	Orifice	0.059 in. dia.	A. U. Stone & Co. Inc.	10430177	
A2735	1	Valve, Relief	55 (± 5 ) psig relief, 45 psig min. reseal	Republic Mfg. Co. P/N 625B-3-8	10430169	
A2736	1	Valve, Solenoid	N C, 3-way, 2-position	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A13
A2737	1	Valve, Solenoid	N.O., 3-way, 2-position	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A14
A2738	1	Valve, Solenoid	N.O., 3-way, 2-position	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A17
A2739	1	Valve, Solenoid	N C, 3-way, 2-position	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A16

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A2740	1	Valve, Solenoid	N C, 3-way, 2-position	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A31
A2741	1	Valve, Solenoid	N.O., 3-way, 2-position	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A32
A2742	1	Valve, Solenoid	N.O. 3-way, 2-position	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A35
A2743	1	Valve, Solenoid	N C, 3-way, 2-position	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A34
A2744	1	Valve, Solenoid	N.O., 3-way, 2-position	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A29
A2745	1	Valve, Solenoid	N C, 3-way, 2-position	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A28
A2746	1	Valve, Solenoid	N.O., 3-way, 2-position	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A19
A2747	1	Valve, Solenoid	N C, 3-way, 2-position	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A20
A2748	1	Valve, Solenoid	N C, 3-way, 2-position	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A22
A2749	1	Valve, Solenoid	N.O., 3-way, 2-position	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A23
A2750	1	Valve, Solenoid	N.O., 3-way, 2-position	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A26
A2751	1	Valve, Solenoid	N C.3-way, 2-position	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A25

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A2752	1	Valve, Solenoid	N C, 3-way, 2-position	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A37
A2753	1	Valve, Solenoid	N. O., 3-way, 2-position	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A38
A2754	1	Valve, Solenoid	N. O., 3-way, 2-position	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A41
A2755	1	Valve, Solenoid	N C, 3-way, 2-position	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A40
A2756	1	Valve, Solenoid	N. O., 3-way, 2-position	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A47
A2757	1	Valve, Solenoid	N C, 3-way, 2-position	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A46
A2758	1	Valve, Solenoid	N C, 3-way, 2-position	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	53A9
A2759	1	Valve, Solenoid	N. O., 3-way, 2-position	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	53A10
A2760	1	Valve, Solenoid	N. O., 3-way, 2-position	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	53A7
A2761	1	Valve, Solenoid	N C, 3-way, 2-position	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	53A6
A2762	1	Valve, Solenoid	N C, 3-way, 2-position	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	53A43
A2763	1	Valve, Solenoid	N. O., 3-way, 2-position	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A44

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A2764	1	Valve, Solenoid	N.O., 3-way, 2-position	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	53A16
A2765	1	Valve, Solenoid	NC, 3-way, 2-position	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	53A15
A2766	1	Valve, Solenoid	NC, 3-way, 2-position	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	53A12
A2767	1	Valve, Solenoid	N.O., 3-way, 2-position	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	53A13
A2768	1	Valve, Solenoid	NC, 3-way, 2-position	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	53A2
A2769	1	Orifice			10428514	
A2770	1	Orifice			10428514	
A2771	1	Valve, Manual	1/2 in., 3000 psig; shutoff	Vacco P/N MV-6P-463-2G	10428576	
A2772 through A3150			are not functionally applicable to this system.			
A3151	1	Valve, Pneumatic	LOX shutoff		75M05605	
A3152 through A3156			are not functionally applicable to this system.			
A3157	1	Coupling, Quick Disconnect	Cold He bottle fill from swing arm No. 2			

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A3158 and A3159			are not functionally applicable to this system.			
A3160	1	Coupling, Quick Disconnect	Main and Replenish LOX to S-IV stage		75M04852	
A3161 through A3164			are not functionally applicable to this system.			
A3165	1	Valve, Check	He purge for S-IV fill line		3871269-501	
A3166 through A3168			are not functionally applicable to this system.			
A3169	1	Orifice	0.040 dia., He purge		75M06686-1	
A3170			is not functionally applicable to this system.			
A3171	1	Orifice	GN <sub>2</sub> purge		75M06713-1	
A3172 through A4004			are not functionally applicable to this system.			
A4005	1	Valve, Pneumatic		Pacific P/N 13648-00	7866160-1	
A4006	1	Valve, Solenoid	4-way, 2-position	Marotta Valve Corp. P/N 804934-1-2	3863940-501	
A4007 and A4008			are not functionally applicable to this system.			

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A4009	1	Transducer, Pressure		Consolidated Vacuum Corp. P/N GTC-004		
A4010	is not functionally applicable to this system.					
A4011	1	Strainer		Westward P/N 25041	7865921-1	
A4012 through A4014	are not functionally applicable to this system.					
A4015	1	Transducer, Pressure		Consolidated Vacuum Corp. P/N GTC-004		
A4016 through A4018	are not functionally applicable to this system.					
A4019	1	Transducer, Pressure		Consolidated Vacuum Corp P/N GTC/004		
A4020	is not functionally applicable to this system.					
A4021	1	Valve, Pneumatic		Pacific P/N 13647-00	7866161-1	
A4022	1	Valve, Solenoid	4-way, 2-position	Marotta Valve Corp. P/N 804934-1-2	3863940-501	
A4023	1	Valve, Pneumatic		Pacific P/N 13647-00	7866161-1	
A4024	1	Valve, Solenoid	4-way, 2-position	Marotta Valve Corp. P/N 804934-1-2	3863940-501	

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A4025	1	Valve, Relief		Ladewig L-1180C-299-3	3864299-1	
A4026			A4026 is not functionally applicable to this system.			
A4027	1	Valve, Check				
A4028			A4028 is not functionally applicable to this system.			
A4029	1	Switch, Pressure				
A4030	1	Valve, Relief				
A4031	1	Snubber, Pressure				
A4032 through A4599			A4032 through A4599 are not functionally applicable to this system.			
A4600	1	Coupling, Retractable		Flexonics Inc. P/N 107435	75M00253	
A4601 through A6507			A4601 through A6507 are not functionally applicable to this system.			
A6508	1	Coupling, Quick Disconnect	3000 psig He, S-I LOX tank pressurization	Wiggins Co. P/N 6400R 107A16	75M02214	
A6509 through A6500			A6509 through A6500 are not functionally applicable to this system.			



Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A6601	1	Coupling, Quick Disconnect	750 psig GN <sub>2</sub> , LOX fill and drain valve control	Wiggins Co. P/N 6300R109A4	75M02210	
A6602 and A6603		are not functionally applicable to this system.				
A6604	1	Coupling, Quick Disconnect	750 psig GN <sub>2</sub> , LOX replenish valve opening control	Wiggins Co. P/N 6300R109A4	75M02210	
A6605 through A6609		are not functionally applicable to this system.				
A6610	1	Coupling, Quick Disconnect	325 psig, LOX bubbling	Wiggins Co. P/N 6200R72A8	75M02207	
A6611 through B149		are not functionally applicable to this system.				
B150	1	Coupling Weldment	3 in.	NASA	20M30050	
B151	1	Valve, Pneumatic	2 in.	Hydromatics, Inc. P/N 131K13B	20M30045	9A18
B152	1	Valve, Pneumatic	6 in., NC, shutoff; 750 psig normal operating pressure	Parker Aircraft Co. P/N F61C0017	20M30042	9A20
B153	1	Nozzle Assembly, Quick Disconnect Coupling	8 in., LOX fill and drain	NASA	20M30202	
B154	1	Coupling, Quick Disconnect	1/4 in.	Wiggins Oil Tool Co. P/N 6105R109A4	20M30390	
B155-1	1	Valve, Pneumatic	8 in., N.C., shutoff; 750 psig normal operating pressure	Parker Aircraft Co. P/N F61C0017	20M30042	9A27

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
B155-2	1	Valve, Pneumatic	8 in., N.C., shutoff; 750 psig normal operating pressure	Parker Aircraft Co. P/N F61C0017	20M30042	9A30
B155-3	1	Valve, Pneumatic	8 in., N.C., shutoff; 750 psig normal operating pressure	Parker Aircraft Co. P/N F61C0017	20M30042	
B155-4	1	Valve, Pneumatic	8 in., NC, shutoff; 750 psig normal operating pressure	Parker Aircraft Co. P/N F61C0017	20M30042	9A36
B155-5	1	Valve, Pneumatic	8 in., NC, shutoff; 750 psig normal operating pressure	Parker Aircraft Co. P/N F61C0017	20M30042	9A39
B155-6	1	Valve, Pneumatic	8 in., NC, shutoff; 750 psig normal operating pressure	Parker Aircraft Co. P/N F61C0017	20M30042	9A42
B155-7	1	Valve, Pneumatic	8 in., NC, shutoff; 750 psig normal operating pressure	Parker Aircraft Co. P/N F61C0017	20M30042	9A45
B155-8	1	Valve, Pneumatic	8 in., NC, shutoff; 750 psig normal operating pressure	Parker Aircraft Co. P/N F61C0017	20M30042	9A48
B156	1	Coupling, Quick Disconnect	1/4 in.	E. B. Wiggins Oil Tool Co. P/N 6005R78A4	20M30138	
B157	1	Coupling, Quick Disconnect	1/4 in.	E. B. Wiggins Oil Tool Co. P/N 6005R78A4	20M30138	
B158	1	Valve, Calibration	3-way, needle	Benton Corp. P/N 15600	10414087	
B159	1	Switch, Differential Pressure	Actuates at 26.02 ( $\pm 0.3$ ) psig diff. press.	Servomechanisms, Inc. P/N 816105, Type TR2124	20M30144	9A21
B160	1	Coupling, Quick Disconnect	1/4 in.	Wiggins Oil Tool Co. P/N 6105R109A4	20M30390	

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
B161-1	1	Sensor, Liquid Level		NASA	20M30429	9A68
B161-2	1	Sensor, Liquid Level		NASA	20M30429	9A70
B162 through B166			are not functionally applicable to this system.			
B167	1	Switch, Pressure	Actuates at 60.0 ( $\pm 0.5$ ) psia, deactuates at 56.0 psia min.	Govt Furnished	60C20057	11A59
B168	1	Valve, Calibration	3-way, needle	Benton Corp. P/N 17600	10414076	
B169	1	Switch, Pressure	Actuates at 67.5 ( $\pm 0.5$ ) psia, deactuates at 64.0 psia min.	Govt. Furnished	60C20058	11A57
B170	1	Valve, Pneumatic	6 in.; fully open at 57 psia, fully closed at 63 psia	Parker Aircraft Co. P/N 536-00 89	60C20129	9A50
B171-1	1	Valve, Pneumatic	Relieves at 57 to 62 psig, reseats at 51 psig	NASA	20M30460	11A54
B171-2	1	Valve, Pneumatic	Relieves at 57 to 62 psig; reseats at 51 psig	NASA	20M30460	11A58
B172	1	Valve, Pneumatic	8 in.	NASA	20M30122	11A56
B173 through B214			are not functionally applicable to this system.			
B215	1	Valve, Solenoid	NC, 3-way, 2-position	Marotta Valve Corp P/N 218263-113	20M30128	11A55

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
B216	1	Valve, Solenoid	N.O., 3-way, 2-position	Marotta Valve Corp. P/N 218263-113	20M30128	9A17
B217-1	1	Valve, Solenoid	NC, 3-way, 2-position	Marotta Valve Corp. P/N 218263-113	20M30128	9A25
B217-2	1	Valve, Solenoid	NC, 3-way, 2-position	Marotta Valve Corp. P/N 218263-113	20M30128	9A28
B217-3	1	Valve, Solenoid	NC, 3-way, 2-position	Marotta Valve Corp. P/N 218263-113	20M30128	9A31
B217-4	1	Valve, Solenoid	NC, 3-way, 2-position	Marotta Valve Corp. P/N 218263-113	20M30128	9A34
B217-5	1	Valve, Solenoid	NC, 3-way, 2-position	Marotta Valve Corp. P/N 218263-113	20M30128	9A37
B217-6	1	Valve, Solenoid	NC, 3-way, 2-position	Marotta Valve Corp. P/N 218263-113	20M30128	9A40
B217-7	1	Valve, Solenoid	NC, 3-way, 2-position	Marotta Valve Corp. P/N 218263-113	20M30128	9A43
B217-8	1	Valve, Solenoid	NC, 3-way, 2-position	Marotta Valve Corp. P/N 218263-113	20M30128	9A46
B218 through B221		are not functionally applicable to this system.				
B222	1	Valve, Solenoid	NC, 3-way, 2-position	Marotta Valve Corp. P/N 218263-113	20M30128	11A53
B223 through B334		are not functionally applicable to this system.				

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
B385	1	Coupling, Quick Disconnect	1 in.	Wiggins Oil Tool Co. P/N 6005R92A16	20M30165	
B386	is not functionally applicable to this system.					
B387	1	Valve, Check	1 in.	Circle Seal Products Co P/N P220T16BB (L)	20M30379	
B388 through B449	are not functionally applicable to this system.					
B450	1	Coupling, Quick Disconnect	1/2 in.	NASA	20M30141	
B451	8	Orifice	0.102 (+ 0.002, - 0.000) in dia.	NASA	20M30199	
B452 through E149	are not functionally applicable to this system.					
E150	1	Coupling, Quick Disconnect		Douglas Aircraft Co. P/N 7851786-1		
E151	1	Valve, Pneumatic	NC	Douglas Aircraft Co. P/N 7851806-503		
E152	1	Container, LOX		Douglas Aircraft Co. P/N 5863804-1		
E153	1	Valve, Pneumatic	Relieves at 50 psia, reseats at 47 psia	Douglas Aircraft Co. P/N 7851777-501		
E154	1	Valve, Pneumatic	Relieves at 50 psia, reseats at 47 psia	Douglas Aircraft Co. P/N 7851777-501		

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
E155	1	Vortex Eliminator		Douglas Aircraft Co. P/N 5851779-1		
E156	1	Sensor, LOX		Douglas Aircraft Co. P/N 7866356-1		
E157 through E161			are not functionally applicable to this system.			
E162	1	Switch, Thermal		Douglas Aircraft Co. P/N 1A65853-1		407A23
E163	1	Orifice		Douglas Aircraft Co. P/N S0268-C6-.093		
E164 and E165			are not functionally applicable to this system.			
E166	1	Valve, Electropneumatic		Douglas Aircraft Co. P/N 7851845-511		
E167	1	Valve, Electropneumatic		Douglas Aircraft Co. P/N 7851845-511		
E168	1	Filter		Douglas Aircraft Co. P/N7851840-1		
E169	1	Orifice		Douglas Aircraft Co. P/N 50268-C6-.031		
E170	1	Switch, Pressure	Actuates at 320 ( $\pm$ 10) psia, deactuates at 115 ( $\pm$ 15) psia	Douglas Aircraft Co. P/N 7871393-1		
E171	6	Valve, Check		Douglas Aircraft Co. P/N 7851843-501		

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
E172	6	Orifice		Douglas Aircraft Co. P/N S0268-C4-.031		
E173 through E211			are not functionally applicable to this system.			
E212	1	Valve, Solenoid	NC, 3-way	Douglas Aircraft Co. P/N 7851827-501		
E213	1	Valve, Solenoid	NC, 3-way	Douglas Aircraft Co. P/N 7851827-501		
E214	1	Valve, Solenoid	NC, 3-way	Douglas Aircraft Co. P/N 7851827-501		
E215	1	Valve, Electropneumatic		Douglas Aircraft Co. P/N 7851767-505		
E216	1	Valve, Electropneumatic		Douglas Aircraft Co. P/N 7851767-503		
E217 through E224			are not functionally applicable to this system.			
E225	1	Coupling, Quick Disconnect		Douglas Aircraft Co. P/N 7851844-501		
E226	1	Valve, Check		Douglas Aircraft Co. P/N 7851843-1		
E227	1	Valve, Check		Douglas Aircraft Co. P/N 7851843-1		
E228	1	Filter		Douglas Aircraft Co. P/N 7851840-1		

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
E229	1	Regulator, Pressure	3000 psig input press., 250 ( $\pm$ 25) psig output press.	Douglas Aircraft Co. P/N 7851841-501		
E230	1	Filter		Douglas Aircraft Co. P/N 7851840-1		
E231	1	Valve, Relief		Douglas Aircraft Co. P/N 7851842-1		
E232	1	Valve, Solenoid	NC	Douglas Aircraft Co. P/N 7851845-511		
E233	1	Sphere, Storage	Gaseous Helium, 3.5 cu. ft at 3000 psig	Douglas Aircraft Co. P/N 7851834-501		
E234	1	Sphere, Storage	Gaseous Helium, 3.5 cu. ft. at 3000 psig	Douglas Aircraft Co. P/N 7851834-501		
E235	1	Sphere, Storage	Gaseous Helium, 3.5 cu. ft. at 3000 psig	Douglas Aircraft Co. P/N 7851834-501		
E236	1	Valve, Electropneumatic	N. O.	Douglas Aircraft Co. P/N 7851845-509		
E237	1	Switch, Pressure	Actuates at 320 ( $\pm$ 10) psia, Reactuates at 115 ( $\pm$ 15) psia	Douglas Aircraft Co. P/N 7871397-1		
E238	1	Valve, Electropneumatic		Douglas Aircraft Co. P/N 7851845-509		
E239 is	not functionally applicable to this system.					
E240	1	Orifice		Douglas Aircraft Co. P/N S4851838D12-375		



Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
E241	1	Heater Assembly		Douglas Aircraft Co. P/N 5851759-503		
E242	1	Igniter				
E243	1	Plenum Chamber		Douglas Aircraft Co. P/N 21522-1		
E244	1	Igniter				
E245	1	Switch, Pressure	Actuates at 2940 ( $\pm$ 25) psia deactuates at 2840 ( $\pm$ 25) psia	Douglas Aircraft Co. P/N 1A18676-1		
E246	1	Switch, Thermal	Actuates at 110 ( $\pm$ 10) F			
E247 through E270			are not functionally applicable to this system.			
E271	1	Sphere, Storage	424 Cu. in., high pressure GH <sub>e</sub>	Douglas Aircraft Co. P/N 1A58515-1		
E272 through E274			are not functionally applicable to this system.			
E275	1	Switch, Differential	Actuates at 4 ( $\pm$ 1) psid, deactuates at 2 ( $\pm$ 1) psid	Douglas Aircraft Co. P/N 7851831-1		
E276 through E279			are not functionally applicable to this system.			
E280	1	Switch, Pressure	Actuates at 52 ( $\pm$ 1) psia, deactuates at 50 ( $\pm$ 1) psia	Douglas Aircraft Co. P/N 7851847-505		

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
E 281	1	Switch, Pressure	Actuates at 44 ( $\pm 1$ ) psia deactuates at 42 ( $\pm 1$ ) psia	Douglas Aircraft Co. P/N 7851847-501		
E 282	is not functionally applicable to this system.					
E 283	1	Switch, Pressure	Actuates at 47 ( $\pm 1$ ) psia deactuates at 45 ( $\pm 1$ ) psia	Douglas Aircraft Co. P/N 7851847-1		
E 284	through E 316 are not functionally applicable to this system.					
E 317	1	Valve, Solenoid	NC	Douglas Aircraft Co. P/N 7851827-501		
E 318	1	Valve, Solenoid	NC	Douglas Aircraft Co. P/N 7851827-501		
E 319	1	Valve, Solenoid	NC	Douglas Aircraft Co. P/N 7851827-501		
E 320	1	Valve, Solenoid	NC	Douglas Aircraft Co. P/N 7851827-501		

## SECTION 3

### MECHANICAL SCHEMATICS

This section provides mechanical schematics that show the functional arrangement of LOX system components listed in section II.

For a definition of the mechanical symbols used, see MSFC-STD-162A.



3.3



3.5

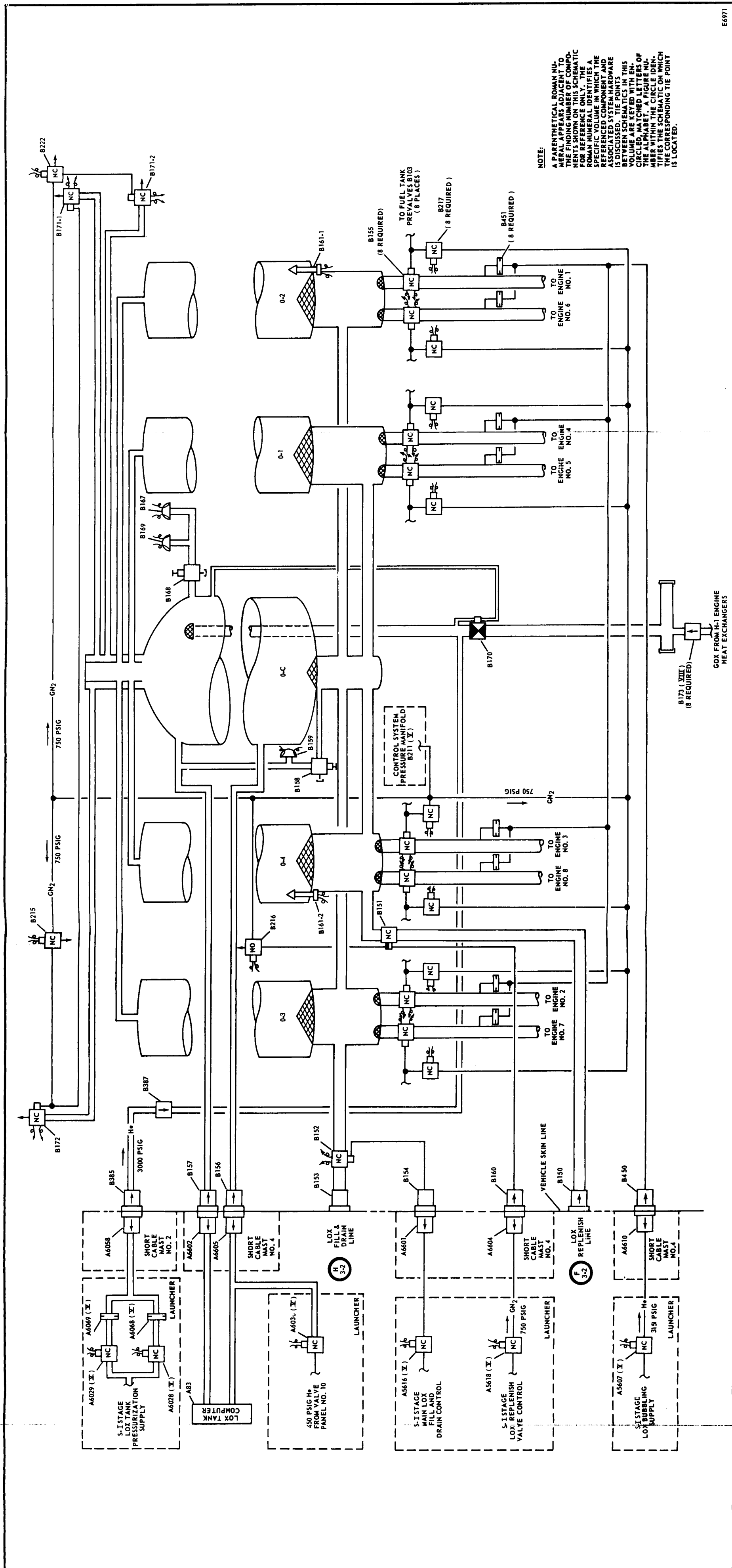


Figure 3-3. Launch Vehicle SA-8, S-I LOX System

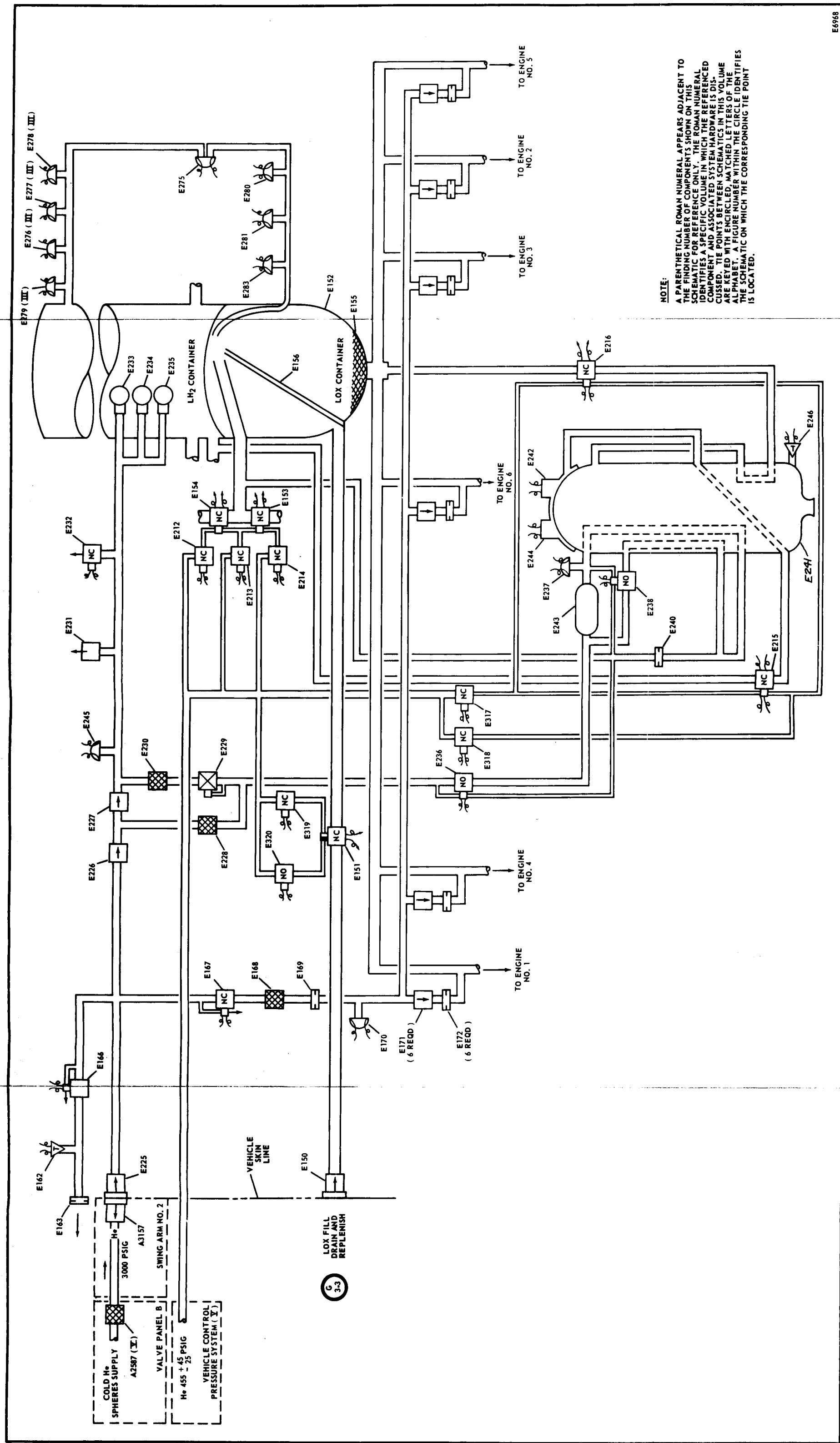


Figure 3-4. Launch Vehicle SA-8, S-IV Stage LOX System

## APPENDIX A

### LISTING OF LAUNCH VEHICLE SA-8 AND LAUNCH COMPLEX 37B VOLUMES

Volume	Title
I	RP-1 Fuel System
II	LOX System
III	LH <sub>2</sub> System
IV	Nitrogen and Helium Storage Facility
V	Pneumatic Distribution System
VI	Environmental Conditioning Systems
VII	Launch Pad Accessories
VIII	H-1 Engine and Hydraulic System
IX	RL10A-3 Engine and Hydraulic System
X	Separation and Flight Termination Systems